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Indian Standard

SPECIFICATION FOR MAGNETIC SOUND TAPE RECORDING AND REPRODUCING EQUIPMENT (REEL-TO-REEL)

PART I METHODS OF MEASUREMENT

UDC 681·846·7 : 621·317

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BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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AMENDMENT NO. 1 DECEMBER 1978
TO
IS:8655(Part I)-1977 SPECIFICATION FOR MAGNETIC SOUND TAPE RECORDING AND REPRODUCING EQUIPMENT (REEL-TO-REEL)
PART I METHODS OF MEASUREMENT

Addendum

(*Page 11, clause 5.4.3, Note*) - Substitute 'NOTE 1' *for* 'NOTE' and add the following new Note:

'NOTE 2 - For measurement for higher accuracy and indication of short term variations this method of measurement is recommended.'

(LTDC 23)

Reprography Unit, ISI, New Delhi

AMENDMENT NO. 2 MAY 1980

TO

IS : 8655 (Part I)-1977 SPECIFICATION FOR MAGNETIC SOUND TAPE RECORDING AND REPRODUCING EQUIPMENT (REEL-TO-REEL)

PART I METHODS OF MEASUREMENT

Alterations

(*Page* 6, *clause* **2.16**) — Substitute the following for the existing clause:

'**2.16 Erasing Attenuation** — The ratio expressed in decibels of the output voltage U_0 derived from reproducing from the specified reference tape a magnetic flux identical to that of the rated recording level at a frequency identical to that of the level section of the specified calibration tape, to the output voltage U derived from reproducing the same section of the tape after erasure on the equipment under test.'

(*Page* 23, *clauses* **8.6, 8.6.1** *and* **8.6.2**) — Substitute the following for the existing clauses:

'**8.6 Erasing Attenuation**

8.6.1 A signal of frequency identical to that of the level section of the specified calibration tape is recorded on the specified reference tape at rated recording level, resulting, on reproduction, in an output voltage U_0.

8.6.2 After an interval of five minutes, the recorded signal is erased on the equipment under test by recording a signal of zero EMF while the adjustable record gain (if any) is set to minimum. The erased section of the tape is reproduced immediately, and the residual output voltage, U, is measured via a narrow band filter to prevent errors due to noise.

8.6.3 The output voltage U is corrected, if necessary, for the transmission factor of the filter at the relevant frequency.

8.6.4 The erased signal ratio is given in decibels by:

$$20 \log_{10} \frac{U_0 \text{ dB}}{U}$$'

(LTDC 23)

1980 0722

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Indian Standard

SPECIFICATION FOR MAGNETIC SOUND TAPE RECORDING AND REPRODUCING EQUIPMENT (REEL-TO-REEL)

PART I METHODS OF MEASUREMENT

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(*Continued on page* 2)

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Indian Standard

SPECIFICATION FOR MAGNETIC SOUND TAPE RECORDING AND REPRODUCING EQUIPMENT (REEL-TO-REEL)

PART I METHODS OF MEASUREMENT

0. FOREWORD

0.1 This Indian Standard (Part I) was adopted by the Indian Standards Institution on 26 September 1977, after the draft finalized by the Recording Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 This standard (Part I) covers the methods of measurement of characteristics of magnetic sound tape recording and reproducing equipment (reel-to-reel) type.

0.2.1 This standard applies to complete apparatus only and not to any component part thereof.

0.3 This standard lays down a single method of measurement for each characteristic so as to achieve the required degree of precision. It is not, however, intended to exclude other alternative methods of measurement for which necessary measuring equipment may be available and which are of equal or greater precision than the method prescribed in this standard.

0.4 While preparing this standard, assistance has been derived from IEC Doc : 60A(Central Office)43 ' Methods of measuring the characteristics of recording and reproducing equipment for sound on magnetic tape' issued by the International Electrotechnical Commission.

0.5 In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

---

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard (Part I) prescribes the conditions and detailed procedures for the measurement of mechanical and electrical performance characteristics of magnetic sound tape recording and reproducing equipment (reel-to-reel) type.

1.1.1 This standard does not apply to special purpose recording and reproducing equipment, such as the following:

a) High speed duplicators,
b) Dictating machines,
c) Cassette recorders,
d) Endless loop cartridge recorders,
e) Artificial reverberation recorders,
f) Logging recorders, and
g) Machines for perforated and other magnetic tape media not included in IS : 4377-1967*.

2. TERMINOLOGY

2.0 For the purpose of this standard, the terms and definitions specified in IS : 1885 (Part III/Sec 3)-1967† shall apply in addition to the following.

2.1 Tape Speed(s) — The speed(s) at which the tape is transported from the supply reel to the take-up reel when the equipment is in the reproducing mode.

2.1.1 *Mean Tape Speed* — The average of the tape speed measured at the beginning, the middle and at the end of the full supply reel of largest diameter.

2.1.2 *Deviation of Mean Tape Speed from Standard Speed* — The ratio of the difference between mean tape speed from standard speed to standard speed, expressed in percentage.

Expressed mathematically:

$$\Delta V = \frac{V_m - V_o}{V_o} \times 100 \text{ percent}$$

where

ΔV = deviation of mean tape speed from standard speed,
V_m = mean tape speed, and
V_o = standard speed.

---

*General requirements for magnetic tapes for sound recording and reproduction.

†Electrotechnical vocabulary: Part III Acoustics, Section 3 Sound recording and reproduction.

2.2 Maximum and Minimum Tape Tension — The maximum and minimum forces, expressed in newtons, acting on the tape at the beginning, the middle and the end of a full supply reel at reproduce speed and at steady state maximum spooling speed.

2.3 Start Time — The elapsed time between operation of the starting device and attaining the specified tape speed within the specified speed fluctuation limits, expressed in seconds.

2.4 Stop Time — The elapsed time between operating the stop device and the time when the tape actually stops, expressed in seconds.

2.5 Spooling Time — The time taken for a full largest diameter reel of a specified tape to be spooled at maximum speed.

2.6 Magnetic Field — The magnetic stray field, generated by the recording and reproducing equipment at a stated distance from its enclosure or from any part associated with the recording and reproducing equipment.

2.7 Reproducing Amplifier Load Impedance — The load impedance of the reproducing amplifier as specified by the manufacturer by which the output terminals of the amplifier are to be terminated for measuring purposes.

2.8 Line Output Voltage — The voltage as specified by the manufacturer which is available across the load impedance (*see* **2.7**), when reproducing the level section of the appropriate calibration tape.

2.9 Maximum Line Output Voltage — The maximum output voltage which the reproducing amplifier will deliver to the specified load impedance for a given level of distortion.

2.10 Reproducing Frequency Response — The relative output levels (in decibels) as a function of frequency when reproducing the specified calibration tape.

2.11 Overall Frequency Response — The relative output levels (in decibels) as a function of frequency at the output terminals of a recording and reproducing equipment (terminated by the specified load impedance) when reproducing a tape recorded with a specified constant level applied to the input terminals of the recording and reproducing equipment.

NOTE — The blank portion of the calibration tape is to be used for the recording.

2.12 Amplitude Non-linearity — The production of unwanted signals in the output voltages of the recording and reproducing equipment, these unwanted signals being related to the input signal frequency.

2.13 Signal-to-Noise Ratio — The ratio expressed in decibels of the output voltage when reproducing the reference tape which has been recorded to a level equal to the level section of the calibration tape to either the wide band or the weighted noise voltage in the absence of the signal, but with the reference tape biased and the input of the recording and reproducing equipment terminated with the specified source impedance.

2.14 Cross Talk — The ratio, expressed in decibels, between two voltages U_A and U'_A occurring at the output terminals of channels *A* and *B* respectively, where U_A is due to the wanted signal intended for channel *A*, and U'_A is due to the unwanted signal produced by channel *A* in channel *B*.

2.15 Channel Separation — The ratio, expressed in decibels, between two voltages U_A and U'_B occurring at the output terminals of a given channel *A*, where U_A is due to the wanted signal intended for channel *A*, and U'_B is due to the unwanted signal produced by channel *B* in channel *A*.

2.16 Erasing Attenuation — The ratio, expressed in decibels, of the output voltage of a flux level 6 dB above flux level of the level section of the appropriate calibration tape to the output voltage of the residual level appearing after the recording has been erased.

2.17 Input Impedance — The internal impedance of the equipment measured between the input terminals.

2.18 Output Impedance — The internal impedance of the equipment between its output terminals.

2.19 Recorded Flux Frequency Response — The relative recorded flux levels in decibels as a function of frequency.

2.20 Recording Sensitivity — Minimum source emf to record calibration tape reference level on the specified reference tape with the recording amplifier at its maximum gain condition.

2.21 Maximum Source EMF — The source emf which results in twice the total harmonic distortion obtained when the record gain is set at maximum and the tape flux is 6 dB below the rated recording level.

2.22 Minimum Source EMF — The source emf which, when recorded on the specified reference tape at maximum record gain, will result in a tape flux which is identical to that of the rated recording level.

2.23 Reference Tape — An unrecorded magnetic tape with specified characteristics, selected as a reference, to enable a comparison to be made with other magnetic tapes or to measure characteristics of magnetic records.

2.24 Azimuth Adjustment — The adjustment necessary to bring magnetic head gaps perpendicular with respect to the direction of movement of the tape.

2.25 Bias Setting — The alternating current to a magnetic recording head which is superimposed on the audio frequency signal in order to diminish the distortion of the recording that otherwise would occur.

3. GENERAL CONDITIONS FOR MEASUREMENTS

3.0 Unless otherwise specified, the measurements shall be made under normal measuring conditions specified in **3.1** to **3.8**.

3.1 Normal Supply Voltage — The rated supply voltage shall be applied to the equipment.

3.1.1 The voltage applied to the equipment shall be held constant within 1·0 percent of the rated value during the measurement of the characteristic.

3.1.2 In case of ac mains operations, the voltage shall be applied at the rated frequency. The harmonic content of ac mains supply voltage shall not exceed 5·0 percent.

3.1.3 In case of battery operation, primary batteries of the type and rated voltage as specified by the manufacturers shall be used.

3.2 Atmospheric Conditions for Testing

3.2.1 Unless otherwise specified all measurements shall be carried under the following atmospheric conditions:

Temperature : 15 to 35 C
Relative humidity : 45 to 75 percent
Air pressure : 86 to 106 kPa (10 mbar = 1 kPa)

3.2.2 The equipment shall be protected from draught and direct radiation.

3.3 Standard Tape Speeds — The standard tape speeds are as follows:

76·2, 38·1, 19·05, 9·53 and 4·76 cm/s

3.4 Reference Frequency — Unless otherwise specified, reference frequency for measurements shall be given below:

Tape Speed cm/s	*Reference Frequency* Hz
76·2	1 000
38·1	1 000
19·05	1 000
9·53	315
4·76	315

3.5 Test Frequencies — For measurements to be made at a number of frequencies, the frequencies shall be selected from IS : 2264-1963*.

3.6 Reference Level — The standard reference level shall be defined as short-circuited surface induction corresponding to a tape flux as specified below:

Tape Speed cm/s	*Reference Level* nWb/m
76·2	320
38·1	320
19·05	320
9·53	250
4·76	250

3.7 Calibration Tape — The calibration tape appropriate to type and speed of the equipment shall be used (*see* IS: 7068-1973†).

NOTE — The calibration tape should be identified by the name of the manufacturer and country of manufacture.

3.8 Accuracy of Test Set-Up — The test set-up employed to carry out measurements in accordance with this standard shall have an accuracy of at least one order better than that specified for the quantity under measurement.

3.9 Reporting — The test report shall clearly indicate the following:

a) Supply voltage, type (ac or dc) and frequency in the case of ac;

b) Atmospheric conditions under which tests are carried out;

c) Any change or necessary adjustments to the equipment done before measurement; and

d) Results of tests.

4. OPERATING CONDITIONS

4.1 Before any measurements are taken, the unit shall operate for at least the stabilization time specified by the manufacturer or 10 minutes whichever is greater.

4.2 Before any measurements are taken, all measuring equipments shall have reached temperature stability.

4.3 Apart from the specified load, the measuring equipment shall not introduce an additional load which would significantly affect the parameters measured.

---

*Preferred frequencies for acoustical measurements.

†Specification for 6·25 mm calibration tape.

4.4 Before measurements are made, it should be ensured that parts of the equipment near or in contact with the tape are maintained clean and demagnetized.

4.5 Unless permanently connected, all noise reductions and/or automatic gain control circuit shall be rendered inoperative.

4.6 The spools used shall conform to IS : 3956-1967* and for test purposes the largest size of spool for which the recorder is designed shall be used.

5. GENERAL MEASUREMENTS

5.1 Visual Examination — The equipment shall be visually examined for checking requirements specified in the relevant specification.

5.2 Operational Test — The preliminary checking shall be done by recording a signal (a) through the microphone, and (b) through the auxiliary input if provided. The signal shall then be reproduced on the loudspeaker provided in the circuit. All mechanical and electrical controls shall be activated and checked for smooth and noise free operation.

5.3 Power Consumption

5.3.1 *For Equipment Powered from the Supply Mains* — The current (I), in amperes, taken from the supply source is measured by means of an ammeter having a class index not inferior to 2·5 (*see* IS : 1248-1968†) when the equipment is operating under maximum voltage and load conditions. The mode (for example, spooling) in which the equipment is operating when this measurement is taken shall be stated.

$$\text{Maximum power consumption} = (I \times \text{maximum rated voltage})\ VA$$

5.3.2 *For Equipment Powered from Batteries* — The current (I) in amperes, taken from the batteries is measured by means of an ammeter having a class index not inferior to 2·5 (*see* IS : 1248-1968†) when the equipment is operating under maximum battery voltage and load conditions. The mode (for example, spooling) in which the equipment is operating when this measurement is taken shall be stated.

$$\text{Maximum power consumption} = (I \times \text{maximum battery voltage})\ \text{watts}$$

5.4 Tape Speed — The method of measurement for the determination of speed characteristics is given when the equipment is in the reproduce mode only, unless otherwise specified, with tape under the constant tension, that is, the tension of the tape when it travels at uniform speed.

NOTE — For a given equipment, it is assumed that its speed characteristics in the record and reproduce modes are identical.

---

*Dimensions of spools for magnetic tapes for sound recording and reproduction.

†Specification for direct acting electrical indicating instruments (*first revision*).

5.4.1 *First Method* — The time t in seconds, taken for a given length of tape (l cms) to pass a fixed point on the equipment in the reproduce mode is measured by means of a suitable timing device.

Then the deviation of mean tape speed from standard tape speed is given by:

$$\Delta V = \frac{(l/t) - V_0}{V_0} \times 100 \text{ percent}$$

5.4.2 *Second Method* — A tape provided with visible lines, which are perpendicular to the tape edges and which are spaced at a distance of d cms apart, is played on the equipment in the reproduce mode while being illuminated by a light source emitting n flashes per second. The number of apparent lines per second (KN) passing a fixed point is counted. If the apparent lines move in the direction of tape travel, N is positive; if they move in the opposite direction, N is negative.

It is assumed that the actual line spacing d is so chosen that the apparent lines are stationary when the tape travels at standard speed. For ease of observation, it is desirable that the apparent line spacing s, be greater than 0·3 cm. For the given tape speed, the factor K depends on the values chosen for n and d. In the following table, n and d are chosen so that the factor K is unity. If other values of n and d (n' and d') have to be used, they should be simple multiples or sub-multiples of n and d. They are related to K as follows:

$$K = \frac{n \times d}{n' \times d'}$$

It should be noted, that the apparent line spacing s will be inversely proportional to the factor K.

V_0 cm/s	*50 Hz Power Supplies*			K
	n Flashes/s	d cm	s cm	
76·2	200	0·381 0	0·381 0	1
38·1	100	0·381 0	0·381 0	1
19·05	50	0·381 0	0·381 0	1
9·53	25	0·381 0	0·381 0	1
4·76	12·5	0·381 0	0·381 0	1

The deviation of mean tape speed from standard tape speed is given by:

$$\Delta V = \frac{N}{n} \times 100 \text{ percent}$$

5.4.3 *Third Method* — A tape carrying a sinusoidal signal which, when reproduced at the relevant standard speed, would result in a reproduce frequency F_0 Hz, is played on the equipment in the reproduce mode. The actual reproduce frequency Fm Hz is measured by means of digital frequency meter.

Then the deviation of mean tape speed from standard speed is given by:

$$\Delta V = \frac{F_m - F_0}{F_0} \times 100 \text{ percent}$$

NOTE — It is recommended that F_0 is chosen to be 3 150 Hz.

5.5 Speed Fluctuations (Wow, Flutter and Drift) — Speed fluctuations shall be measured in accordance with IS : 8152-1976*.

5.6 Maximum and Minimum Tape Tension

5.6.1 Largest diameter reels shall be used and measurements taken at the beginning, the middle and the end of a full supply reel. Measurements shall be taken between supply reel and capstan, capstan and take-up reel, and where applicable, between capstans. The maximum and minimum values of these six (nine where applicable) readings are quoted for reproduce speed and steady state maximum spooling speed.

5.6.2 A section of the tape from each location specified in **5.6.1** is, in turn, passed over an idler roller carried by a rod connected to a dynamometer, and extended until the included angle of the tape is 120 .

5.6.3 The reading on the dynamometer is equal to the tension N in the tape.

NOTE - If dynamometer is not available, the alternative methods given in Appendix A may be followed.

5.7 Start Time

5.7.1 Largest diameter reel shall be used. A test frequency of 3 150 Hz recorded on the equipment throughout the full reel of tape shall be reproduced on the equipment from the beginning, the middle, and the end of the supply reel. The reproduced test signals shall be fed into a wow and flutter meter (complying with IS : 8152-1976*) centred on 3 150 Hz and the output from the meter fed to a graphic recorder. The time taken from the operation of the starting device till the meter indicates steady flutter figure is noted from the graphic recorder. The maximum of these measurements shall be quoted.

---

*Method of measurement of speed fluctuations in sound recording and reproducing equipment.

5.8 Stop Time

5.8.1 *Stop Time from Record/Reproduce Speed* — Largest diameter reels shall be used. While playing at reproduce speed, the stopping device shall be operated. The time taken between operating the stopping device and the tape stopping shall be measured by means of a suitable timing device. The measurement shall be carried out at the beginning, the middle and the end of a full supply reel and at each of these positions of tape, three readings shall be taken. The maximum time shall be quoted.

5.8.2 *Stop Time from Maximum Spooling Speed* — Largest diameter reel shall be used. While spooling the tape at maximum speed, the stopping device shall be operated. The time taken between operating the stopping device and the tape stopping shall be measured by means of a suitable timing device. The measurement shall be carried out at the beginning, the middle and the end of a tape from a full supply reel and at each of these positions of tape, three readings shall be taken. Measurements shall be made in both directions of travel. The maximum time shall be quoted.

5.9 Spooling Time

5.9.1 Largest diameter reels containing specified length of tape shall be placed in the equipment and the spooling control (if any) set to maximum. A suitable timing device and the spooling device are actuated and the timing device is stopped when the length of tape comes to an end. Measurements shall be made in both direction or travel.

Note — It is usual for the specified length of tape to be the maximum that the machine can accommodate.

5.10 Head Gap Configuration for Multi-track Heads — The relative positions of the head gaps should be measured by means of a microscope. It may be necessary to remove the head from the machine in order to make this measurement. The position of the head gaps shall be aligned with track configuration specified in relevant Indian Standard (*see* IS : 4377-1967*).

5.11 Mechanical Noise — This measurement shall be carried out under free field conditions as in an anechoic chamber. The equipment should be placed in the middle of the working floor on a strong hardboard and sponge rubber of about the same dimensions as the base of the tape recorder. The noise level should then be measured by placing the microphone at a distance of 1 metre above the equipment. It is also to be ensured that the noise level of the free field room is at least 10 dB lower than the specified noise level of the equipment.

---

*General requirements for magnetic tapes for sound recording and reproduction.

5.12 Magnetic Stray Field — The recorder is placed in the recording mode and the individual frequency components of the stray field are measured using a one-third octave filter and the search coil at a specified distance and direction from the equipment.

NOTE — Details of search coil are under consideration.

5.13 RF Shielding — Under consideration.

5.14 Azimuth Adjustment — The equipment shall be brought under normal working conditions. When reproducing the azimuth section of calibration tape, the azimuth shall be adjusted in such a way that maximum output voltage is reached. In case of stereo recording, phase relation between the tracks shall be measured (with a suitable phase meter).

5.15 Bias Setting — The equipment shall be brought under normal working conditions. An input signal at a reference frequency of 1 kHz and a level low enough to prevent overload of the tape, shall be recorded at the speed of 19·05 cm/s, the bias shall be so adjusted that the output voltage after having reached its maximum value is 2 dB below the maximum output voltage or as recommended by the manufacturer. Reference section of the calibration tape shall be used for this purpose. The measurement is to be repeated for all the speeds for which the equipment is designed.

NOTE — The reference frequency for different speeds shall be in accordance with **3.4**.

6. RECORDING PERFORMANCE

6.1 Input Impedance

6.1.1 *Balanced Input*

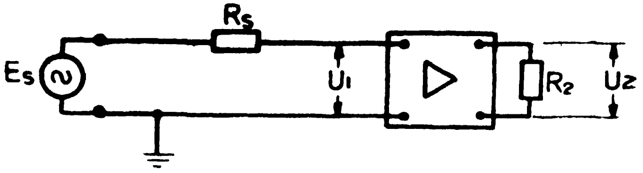
6.1.1.1 *Free from earth* — If the input circuit of the amplifier is balanced and free from connections to the earth (or chassis), the following procedure shall be followed:

a) The amplifier is brought under normal working conditions, using a source with one earthed terminal, as shown in Fig. 1A.

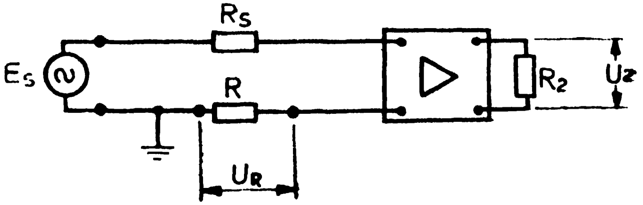
b) The output voltage U_2 and input voltage U_1 are then measured. A known resistor of value R approximately one-tenth of the input impedance is connected in series with the input terminals as shown in Fig. 1B. The source emf is readjusted to obtain the initial output voltage U_2. The voltage U_r appearing across the resistor R is then measured.

The modulus of the input impedance is given by:

$$\frac{U_1}{U_r} \cdot R$$



1A For Measurement of U_1 and U_2



1B For Measurement of U_r

FIG. 1 MEASUREMENT OF INPUT IMPEDANCE FOR BALANCED INPUT FREE FROM EARTH

6.1.1.2 *Connected to earth* — If the input circuit has a centre tap connected to the earth or chassis, the following procedure shall be followed:

a) The amplifier is brought under normal working conditions, using a source free from earth (or chassis), as shown in Fig. 2A.

b) The output voltage U_2 is measured. The input voltage U_1 is measured by means of a balanced voltmeter. A known resistor of value R is connected in series with the input terminals as shown in Fig. 2B. The source emf is readjusted to obtain the initial output voltage U_2. The voltage U_r appearing across the resistor R is then measured by means of a balanced voltmeter.

The modulus of the input impedance is given by:

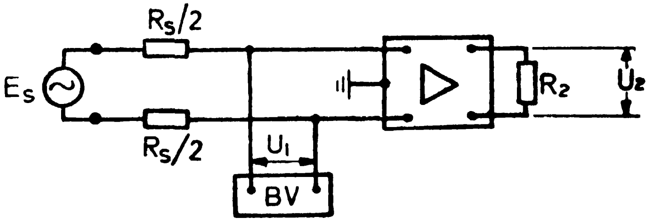
$$\frac{U_1}{U_r} \cdot R$$

6.1.2 *Unbalanced Input* — The amplifier is brought under normal working conditions. A shielded transformer is inserted between the source emf and the amplifier. The shields are connected as shown in Fig. 3A. The voltage appearing at the secondary terminals of the transformer is adjusted to a value of 10 dB below the rated source voltage.

The output voltage U_2 and input voltage U_1 are measured. A known resistor of value R is connected in series between one of the secondary terminals of the transformer and ground as shown in Fig. 3B. The voltage appearing at the secondary terminals of the transformer is adjusted to obtain the initial output U_2. The voltage U_r appearing across resistor R is then measured.

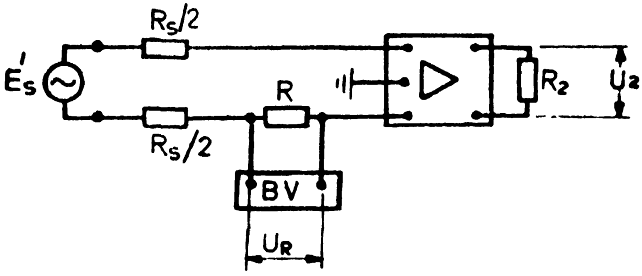
The modulus of the input impedance is given by:

$$\frac{U_1}{U_r} \cdot R$$



BV = Balanced voltmeter

2A For Measurement of U_1 and U_2



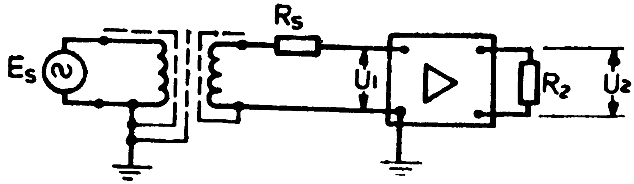
BV = Balanced voltmeter

2B For Measurement of U_r

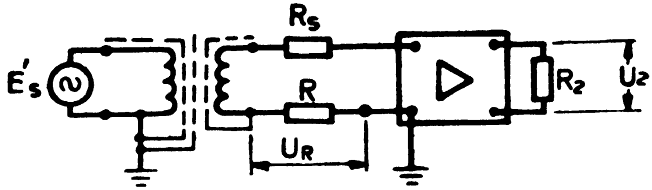
Fig. 2 Measurement of Input Impedance for Balanced Input, Connected to Earth

6.2 Recorded Flux Frequency Response

6.2.1 The relative recorded flux levels can be derived from the reproducing frequency response (**7.5**) and the overall frequency response (**8.1**).



3A For Measurement of U_1 and U_2



3B For Measurement of U_r

FIG. 3 MEASUREMENT OF INPUT IMPEDANCE FOR UNBALANCED INPUT

6.2.2 Overall frequency response minus reproducing frequency response equals recorded frequency response.

6.3 Minimum Source EMF — The level section of the appropriate calibration tape is reproduced and the output voltage measured. With the recording gain control set to maximum, the input level to the equipment is adjusted until the flux level recorded on reference tape equals the flux level on the calibration tape. The source emf is then measured.

6.4 Maximum Source EMF

6.4.1 The level section of the appropriate calibration tape is reproduced and the output voltage measured. With the recording gain control set to maximum the input level to the equipment is adjusted until the flux level on the reference tape equals the flux level on the calibration tape. The third harmonic distortion at this level is then measured. The recording gain control is adjusted to successive positions of lower gain whilst the source emf is increased to restore the initial output voltage until the measured distortion is just greater than that originally measured.

6.4.2 Maximum source emf is the maximum input level the recording amplifier will accept.

7. REPRODUCING PERFORMANCE

7.1 Output Impedance — The specified load impedance, R_0 is replaced, in succession, by resistors of value $0{\cdot}8\ R_0$ and $1{\cdot}2\ R_0$. In each case the level section of the specified calibration tape is reproduced, and each output voltage is measured ($U_{0{\cdot}8}$, $U_{1{\cdot}2}$).

$$\text{Output impedance} = \frac{U_{1{\cdot}2} - U_{0{\cdot}8}}{\dfrac{U_{0{\cdot}8}}{0{\cdot}8\,R_0} - \dfrac{U_{1{\cdot}2}}{1{\cdot}2\,R_0}}$$

NOTE — The output impedance will generally be a complex quantity. However, within the specified frequency range the output impedance will approximate to a pure resistance, and the results obtained by this method are generally sufficiently accurate in practice.

7.2 Line Output Voltage — The line output voltage shall be measured across the stated load impedance connected to the line output terminals.

7.3 Maximum Line Output Voltage — The level section of the appropriate calibration tape is reproduced and the reproducing gain control adjusted so that the given level of distortion is measured. If the range of the reproducing gain control (*s*) is insufficient to produce the given level of distortion, a signal can be inserted into the reproducing amplifier *via* a coil placed in front of the reproducing head. The output voltage U_2 at this distortion level is then measured.

7.3.1 Maximum line output voltage margin expressed in decibels is $20 \log_{10} U_2/U_1$ where U_1 is the voltage specified.

7.4 Unbalance of Output — Each of the balanced output terminals of the equipment under test is connected to the unknown arm of capacity measurement bridge and its capacitance to earth is measured.

NOTE — Normally in capacitance bridges 1 kHz signal is used as the ac signal. As such the unbalance as measured by the above method will give unbalance of the output at 1 kHz.

7.5 Frequency Response

7.5.1 If adjustable reproduce gain controls are provided on the equipment, they shall be adjusted to give an output U_0 when reproducing the rated recording level. If adjustable reproduce equalization controls are provided on the equipment, they shall be adjusted to give the closest approximation to the specified reproducing characteristic when reproducing the frequency response section of the specified calibration tape, due correction being made for the recording characteristic of the specified calibration tape.

7.5.2 The frequency response section of the appropriate calibration tape is reproduced and the measured variation of output level (in decibels) as a function of frequency are plotted in graphical form.

7.5.3 The reproducing frequency response of each channel at all relevant speeds is quoted in graphical form.

The scale ratio should be such that the length representing one decade of frequency is the same as the length representing 25 or 50 dB difference in output level. The preferred length per decade is 50 mm. If the size of the graph is changed, the scale ratio should be left unaltered (*see* IS : 8159-1976*).

NOTE — Graphs should be drawn with frequency in Hz as abscissae on a logarithmic scale, and output level in dB as ordinates on a linear scale.

7.6 Signal-to-Noise Ratio (Electronic Noise) — The rated recording level is reproduced, resulting in an rms output voltage U_0. After removal of the tape and its replacement by a non-magnetic antistatic tape the equipment is again switched into the reproduced mode and the rms output voltage, U is measured *via* the filters specified below, due allowance being made for the transmission factor of the relevant filter at the relevant frequency:

a) Unweighted signal/noise ratio	A band pass filter, which has a reasonably constant transmission factor between 22 to 22 000 Hz, but which decreases outside this frequency band at the rate specified for octave band filters with medium frequencies of 31·5 Hz and 16 000 Hz in IS : 6964-1973† shall be used.
b) Weighted signal/noise ratio	A filter having a transmission factor in accordance with the A-weighting curve specified in Appendix B and Fig. 4 shall be used.
c) Octave signal/noise ratio	Octave filters in accordance with IS : 6964-1973† shall be used.
d) Third-octave signal/noise ratio	Third-octave filter in accordance with IS : 6964-1973† shall be used.

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*Specification for scales and sizes for plotting frequency characteristics and polar diagrams.

†Specification for octave, half-octave and third-octave band filters for analysis of sound and vibrations.

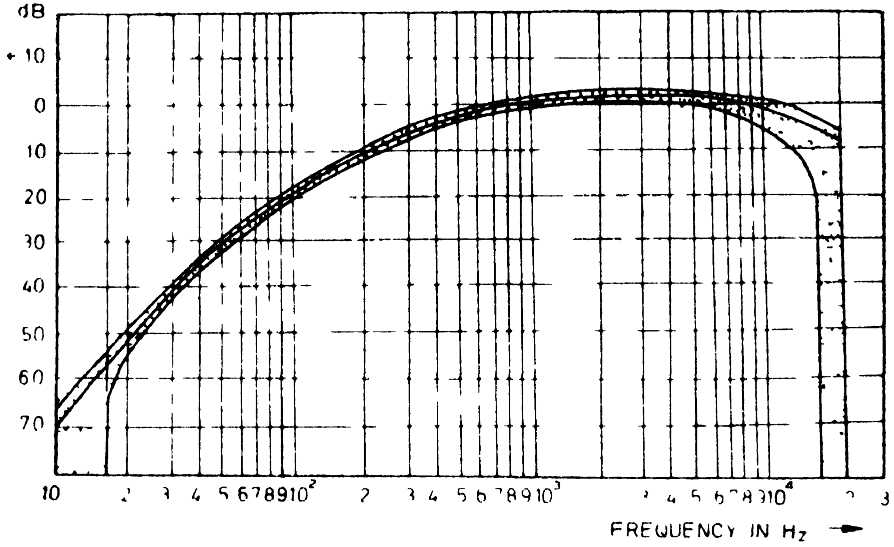

FIG. 4 WEIGHTING CURVE A

7.6.1 *Results* — Signal noise ratio calculated from the expression $20 \log_{10} \frac{U_0}{U}$ dB, shall be reproduced as follows:

a) Unweighted signal/noise ratio	A single figure is quoted.
b) Weighted signal/noise ratio	A single figure is quoted
c) Octave signal noise ratio	A graph (*see* IS 8159-1976*) showing the ratio as a function of frequency.
d) Third-octave signal/noise ratio	A graph (*see* IS : 8159-1976*) showing the ratio as a function of frequency.

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*Specification for scales and sizes for plotting frequency characteristics and polar diagrams.

8. OVERALL PERFORMANCE

8.1 Overall Frequency Response

8.1.1 If adjustable response gain and equalization controls are provided on the equipment, they shall be adjusted to the settings determined in 7.5. If adjustable record gain controls are provided on the equipment, they shall be adjusted so that an input signal emf of U_1, shall result in a tape flux on the specified reference tape which is identical to the rated recording level.

8.1.2 If adjustable record equalization controls are provided on the equipment, they shall be adjusted to give the closest possible approximation to a flat response when reproducing the specified reference tape on which constant amplitude signals at frequencies corresponding to those of the frequency response section of the specified calibration tape have been recorded.

8.1.3 Constant amplitude signals at frequencies corresponding to those on the frequency response section of the specified calibration tape are fed to the input of the equipment and are recorded on the specified reference tape section of the calibration tape. The constant amplitude shall be adjusted so that the frequency corresponding to that on the level section of the specified calibration tape is recorded to reproduce at approximately the same level as the frequency response section of the specified calibration tape.

8.1.4 The recorded reference tape is reproduced and the measured variations in output level (in dB) are plotted as a function of frequency within the specified frequency range in graph form. The resulting curve, the overall characteristic, is compared with a flat response and the maximum positive and negative differences between the two curves are noted. The measurement is repeated for each channel at each relevant speed.

8.1.5 The measurement shall, preferably, be presented in graph form (*see* IS : 8159-1976[*]) for each channel at each relevant speed. Alternatively the maximum positive and negative deviations of the overall characteristic from a flat response within the specified frequency range expressed in ±dB may be quoted for each channel at each relevant speed.

8.2 Amplitude Non-linearity

8.2.1 An input signal having a frequency equal to the level section of the appropriate calibration tape shall be recorded on the blank portion

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[†] Specification for scales and sizes for plotting frequency characteristics and polar diagrams.

of calibration tape so that the reproduced output equals the output from the level section of the appropriate calibration tape. Whilst reproducing this signal the total harmonic distortion is measured. This measurement shall not be done while recording the test signal.

8.2.2 Total harmonic distortion produced when recording a given flux level shall be expressed as a percentage.

8.3 Signal-to-Noise Ratio

8.3.1 The adjustable response gain and equalization controls (if any) shall be set as determined in **7.5** and the adjustable record gain and equalization controls (if any) shall be set as determined in **8.1**.

An input signal emf of U_i recorded on the specified reference tape is reproduced resulting in an output voltage U_o. With the record input terminated by the rated source impedance, an input signal of zero emf recorded on the specified reference tape is reproduced *via* the filters specified below and the output voltage U, corrected, if necessary for the transmission factor of the relevant filter at the relevant frequency, is measured:

a) Unweighted signal/noise ratio	A band pass filter, which has a reasonably constant transmission factor between 22 to 22 000 Hz, but which decreases outside this frequency band at the rate specified for octave band filters with medium frequencies of 32·5 Hz and 16 000 Hz in IS : 6964-1973* shall be used.
b) Weighted signal/noise ratio	A filter having a transmission factor in accordance with A-weighting curve (*see* Fig. 4) specified in Appendix B shall be used.
c) Octave signal/noise ratio	Octave filters in accordance with IS : 6964-1973* shall be used.
d) Third-octave signal/noise ratio	Third-octave filter in accordance with IS : 6964-1973* shall be used.

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*Specification for octave, half-octave and third-octave band filters for analysis of sound and vibrations.

8.3.1.1 *Result* — Signal/noise ratio calculated from the expression $20 \log_{10} \frac{U_o}{U}$ dB, shall be reproduced as follows:

a) Unweighted signal/noise ratio	A single figure is quoted.
b) Weighted signal/noise ratio	A single figure is quoted.
c) Octave signal/noise ratio	A graph (*see* IS : 8159-1976*) showing the ratio as a function of frequency.
d) Third-octave signal/noise ratio	A graph (*see* IS : 8159-1976*) showing the ratio as a function of frequency.

8.4 Output Power Measurement — The blank section of the appropriate calibration tape shall be recorded with 1 kHz peak recording level signal, that is, 3 percent distortion. This tape shall be played back and the output shall be measured at the maximum setting of level control.

8.5 Separation Between Adjacent Tracks

8.5.1 The adjustable reproduce gain and equalization controls (if any) shall be set as determined in **7.5** and the adjustable record gain and equalization controls (if any) shall be set as determined in **8.1**.

8.5.2 Constant amplitude signals at frequencies corresponding to those of the frequency response section of the specified calibration tape are fed to the input of one channel *A* of the equipment and are recorded on the specified reference tape. The constant amplitude shall be adjusted so that the frequency corresponding to that on the level section of the specified calibration tape is recorded to reproduce at approximately the same level as the frequency response section of the specified calibration tape.

8.5.3 At the same time, the record input of the adjacent channel *B* which is terminated by the rated source impedance, is fed with signals of zero amplitude and shall also be in the record mode.

8.5.4 The procedure is repeated with the signal input to the channels *A* and *B* reversed.

8.5.5 The recorded reference tape is reproduced *via* the third-octave filters specified in IS : 6964-1973† whose centre frequencies correspond to those of the recorded signals. For each frequency the output from each channel for wanted signal (U_A, U_B) and unwanted signal (U_A, U_B) are measured.

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*Specification for scales and sizes for plotting frequency characteristics and polar diagrams.

†Specification for octave, half-octave and third-octave band fiters for analysis of sound and vibrations.

8.5.6 Separation between adjacent tracks is given by:

$$20 \log_{10} \frac{U'_A}{U''_A} \text{ or } 20 \log_{10} \frac{U'_B}{U''_B}$$

8.5.7 The ratio is plotted in graph form (*see* IS : 8159-1976*) as a function of frequency, and the least favourable curve is presented.

8.6 Erasing Attenuation

8.6.1 A flux level 6 dB above the flux level of the level section of the appropriate calibration tape is recorded, then reproduced and the output level U_2 noted. The recording is then erased and the erased tape is reproduced *via* a third-octave filter, whose centre frequency is equal to the frequency of the original recording, and the output voltage U_1 measured.

8.6.2 The erasing attenuation in decibels is given by:

$$20 \log_{10} \frac{U_2}{U_1}$$

APPENDIX A

[*Clause* 5.6.3 (*Note*)]

ALTERNATE METHODS OF MEASUREMENT OF TAPE TENSION

A-1. SPRING BALANCE METHOD

A-1.1 A spring balance with a measuring range of 0 to 200 g is used. A loop is formed at the end of the tape which can be hooked on to the spring balance. The spool (with the tape wound on it) is placed on the take-up or the feed turntable as required for measuring the tension on the take-up side or on the feed side (counter tension). Without threading the tape through the capstan the tape transport is started so that the tape is pulled by the respective turntable. The spring balance is held initially to hold the tape taut and is then slowly moved or released so that the tape gets wound on to the spool; a steady reading can be obtained when both the tape and the spring balance advance together without relative movement between them. The reading of the spring balance in this fairly steady state gives the tension in the tape.

A-2. PRESET TENSION GAUGE METHOD

A-2.1 A preset type of tension-gauge may also be used in the place of the spring balance. The tension gauge is adjusted by means of the thumb screw so that when the tape loop is attached to the tip of the feeler and the transport started, the tension of the tape is just enough to produce relative movement between the feeler and the gauge during the slow winding process. The tension is then read off directly from the scale.

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*Specification for scales and sizes for plotting frequency characteristics and polar diagrams.

APPENDIX B

[*Clauses* 7.6 (b) *and* 8.3.1 (b)]

RELATIVE RESPONSES AND ASSOCIATED TOLERANCES FOR FREE FIELD CONDITIONS

Frequency Hz (c/s)	Curve A dB	Tolerance Limits dB	
10	— 70·4	3	— ∞
12·5	— 63·4	3	— ∞
16	— 56·7	3	— ∞
20	— 50·5	3	— 3
25	— 44·7	2	— 2
31·5	— 39·4	1·5	— 1·5
40	— 34·6	1·5	— 1·5
50	— 30·2	1·5	— 1·5
63	— 26·2	1·5	— 1·5
80	— 22·5	1·5	— 1·5
100	— 19·1	1	— 1
125	— 16·1	1	— 1
160	— 13·4	1	— 1
200	— 10·9	1	— 1
250	— 8·6	1	— 1
315	— 6·6	1	— 1
400	— 4·8	1	— 1
500	— 3·2	1	— 1
630	— 1·9	1	— 1
800	— 0·8	1	— 1
1 000	0	1	— 1
1 250	0·6	1	— 1
1 600	1·0	1	— 1
2 000	1·2	1	— 1
2 500	1·3	1	— 1
3 150	1·2	1	— 1
4 000	1·0	1	— 1
5 000	0·5	1·5	— 1·5
6 300	— 0·1	1·5	— 2
8 000	— 1·1	1·5	— 3
10 000	— 2·5	2	— 4
12 500	— 4·3	3	— 6
16 000	— 6·6	3	— ∞
20 000	— 9·3	3	— ∞

NOTE — These responses are based on frequencies calculated from 1 000 × $10^{n/10}$, where *n* is a positive or negative integer.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Conversion*
Force	newton	N	1 N = 0 101 972 kgf
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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